DOCUMENT RESUME

ED 226 337 CS 007 013

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TITLE Readability Grade Levels of Selected Navy Technical School Curricula. Focus on the Trained Person.
INSTITUTION Naval Training Analysis and Evaluation Group, Orlando, Fla.
REPORT NO TAEG-TM-83-2
PUB DATE Feb 83
NOTE 26p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Curriculum Development; *Instructional Materials; Military Personnel; *Military Training; *Readability; Reading Achievement; Reading Materials; *Reading Research; *Technical Education; Textbook Evaluation
IDENTIFIERS *Naval Training; Navy

ABSTRACT

The U.S. Navy conducted a study to determine the readability grade level of materials used in its technical training schools curricula as a basis for (1) establishing minimal reading competencies for those schools, (2) identifying problem textual materials used in those schools, and (3) choosing additional school curricula for readability analysis. Selection of schools used in the study was based on annual completion, percent of students set back, and withdrawal for academic reasons. The readability analyses were obtained using the Computer Readability Editing System (CRES) and calculated with the Flesch-Kincaid readability formula. The results indicated that the electronics technician curriculum had the most difficult readability grade level, 12.6. The least difficult course, machinery repairman, was found to have a readability grade level of 8.1. The electronics technician curriculum also had the highest percentage of setbacks and the third highest percentage of academic attrition of the 11 courses studied. The fact that the mean readability grade level of the 11 sampled courses correlated positively with setback rates indicated that readability may be contributing to the setback problem. Based on these results, it was recommended that readability grade level standards be set to match the mean reading ability of the intended reader and that the CRES be used to assess and improve all technical curriculum materials. (HTH)

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TRAINING ANALYSIS AND EVALUATION GROUP

TECHNICAL MEMORANDUM 83-2

READABILITY GRADE LEVELS OF SELECTED NAVY TECHNICAL SCHOOL CURRICULA

U.S. DEPARTMENT OF EDUCATION
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ORLANDO, FLORIDA 32813

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Technical Memorandum 83-2

READABILITY GRADE LEVELS OF SELECTED NAVY TECHNICAL SCHOOL CURRICULA

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February 1983

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Memorandum 83-2	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) READABILITY GRADE LEVELS OF SELECTED NAVY TECHNICAL SCHOOL CURRICULA		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. W. Losa, James A. Aagard, and J. Peter Kincaid		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Training Analysis and Evaluation Group Department of the Navy Orlando, FL 32813		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE February 1983 13. NUMBER OF PAGES 19
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Readability
Reading
Training Materials
Technical Schools
Technical Curriculum
Technical Vocabulary

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The curriculums of 11 Navy technical schools were surveyed for readability. Samples from courses with high throughput, academic attrition, and setback rates were analyzed using the Computer Readability Editing System (CRES). Results showed a moderately high correlation between readability grade level and setback rates (r = .49). Schools which embody high technology (such as Electronics Technician "A" School and Advanced First Term Avionics) showed both high readability and high setback rates.

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S/N 0102-LF-014-6601

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Mean readability grade levels ranged from 12.6 for the Electronics Technician "A" School down to 8.1 for the Machinery Repairman "A" School.

This study supports requirements set forth in OPNAV Instruction 1510.11, "Enlisted Fundamental Skills Training,' to help the Chief of Naval Education and Training plan for "appropriate fundamental skills training interventions to upgrade basic competencies in support of military operations."

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SECTION I

INTRODUCTION

Many sailors entering "A" schools lack the reading skills to cope successfully with school reading materials. For example, at the Operations Specialist "A" School, Dam Neck, Virginia, more than 1,000 students per year require remedial reading instruction.[1] In addition, the Chief of Naval Operations has stated that a "substantial proportion of recruits read below the 10th grade level. Academic Remedial Training programs at the Recruit Training Commands and the Job Oriented Basic Skills program are limited in scope and cannot overcome the entire Navy (reading) problem which has its roots in our public educational system. This situation is projected to become more critical as we face the declining manpower pool of the 1980's."[2]

According to the most recent Navy figures, 25 percent of entering Navy recruits read at or below the ninth grade level.[3] An initiative addressing the need to improve reading skills of enlisted personnel is contained in OPNAV Instruction 1510.11.[4] The instruction establishes a policy of providing "appropriate fundamental skills training interventions to upgrade basic competencies[5] in support of military operations." The instruction further states that the Chief of Naval Education and Training (CNET) has the responsibility to: (1) design and implement training programs to achieve competency goals identified for Navy training courses and (2) determine the skills needed to comprehend technical information. Because of the long-term involvement of the TAEG with the basic skills program of the NAVEDTRACOM (e.g., Kincaid and Curry, 1979; Aagard, Pereyra, and Kincaid, 1981; Brown, 1982), the CNET tasked the TAEG to determine the readability grade levels of selected "A" school course reading materials.[6,7] As part of the tasking for this study, TAEG completed an assessment of the readability level of essential job reading material for nonrated Navy personnel (Hamel, Aagard, and Kincaid, 1982).

PURPOSE

The purpose of the present study was to determine the readability grade levels (RGL) of materials used in the curricula of selected "A" schools (those with high throughput and/or attrition) as a basis for: (1) establishing minimal reading competencies for those schools, (2) identifying problem textual materials used in these schools, and (3) choosing additional school curricula for readability analysis.

[1] NAVSWC 031507Z Aug 1982

[2] CNO ltr 204564 of 21 Apr 1980

[3] CMI Recruit Population Analysis Report produced by the Management Information and Instructional Systems Activity (MIISA)

[4] OPNAVINST 1510.11, Enlisted Fundamental Skills Training

[5] Basic competencies include not only reading but also mathematics and communications skills

[6] CNET ltr of 13 July 1981

[7] Advanced First Term Avionics, a post-"A" School, was also included in the study

ORGANIZATION OF THE REPORT

In addition to this introduction, the report contains three additional sections and two appendices. Section II presents the approach used in the readability grade level analysis and the rationale for selecting the particular schools. Section III contains the study results. Section IV presents the conclusions and recommendations. Appendix A is a list of the sampled reading materials, with readability grade levels. Appendix B contains an example for one school of technical words, identified by the computer readability analysis not ordinarily in the vocabulary of beginning students. Such lists should prove useful for developing vocabulary instructional materials for students entering Navy technical schools.

SECTION II

APPROACH

This section describes the approach taken in: (1) selecting courses in which difficult reading material might be a problem and (2) conducting the readability analysis.

SELECTION OF COURSES

Resources permitted the study of only a limited number of school curricula so a technique for prioritizing schools most likely to benefit from a readability analysis was required. The priorities established in selecting schools for this study were based on three criteria: (1) annual throughput, (2) percent of students set back, and (3) percent of students attriting for academic reasons.

Table 1 shows the schools selected and data for the three selection criteria for the year ending 31 August 1982. Annual throughput varied considerably ranging from 3,247 for Avionics "A" School to 78 for Mineman "A" School. All selected schools experienced a high rate of setback (ranging from 16 percent to 88 percent) and most experienced a high rate of academic attrition (8 out of 11 had 10 percent or greater).

READABILITY ANALYSIS

Instructional personnel of the schools (either an education specialist or the officer in charge) selected course material for analysis which they judged to be most important in the curriculum. TAEG was also furnished a curriculum guide to determine the appropriate pages for analysis. These materials were then sampled according to the DOD specification dealing with readability (MIL-M-38784A, Amendment 6, Department of Defense, 1982). For some of the schools (AV, AE, AFTA, and AW located at NAS Memphis) materials were collected by a TAEG representative. At the other schools, materials were sent after one or more telephone conversations. In all cases, TAEG personnel contacted school personnel knowledgeable about the school's curriculum to verify that the selected materials were the most important ones for their course.

MIL-M-38784A, Amendment 6, prescribes a technique for determining the readability of course materials and a technique for sampling materials for the analysis. For a document containing 100 or more pages of textual material, 10 samples of approximately 200 words are selected and a readability grade level is obtained using the Flesch-Kincaid readability formula (Kincaid, Fishburne, Rogers, and Chissom, 1975). This formula has two factors: (1) sentence length in words and (2) word length in syllables. It provides grade level according to the formula:

Grade level = 0.39 (Average No. Words/Sentence) + 11.8 (Average No. Syllables/Word) - 15.59.

TABLE 1. ANNUAL THROUGHPUT, PERCENT SETBACK, AND PERCENT ACADEMIC ATTRITION FOR SELECTED SCHOOLS*

Course Title	Annual Throughput	Setback %	Attrition %
Avionics (AV)	3,247	16	11
Electronics Technician (ET)	2.275	88	25
Aviation Electrician's Mate (AE)	1,672	34	7
Advanced First Term Avionics (AFTA)	761	39	4
Air Traffic Controller (AC)	745	33	38
Data Systems Technician (DS)	635	18	8
Aviation Antisubmarine Warfare Operator (AW)	558	37	10
Machinery Repairman (MR)	391	25	11
Strategic Weapons Systems Electronics (SWSE)	357	57	32
Aerographer's Mate (AG)	226	35	16
Mineman (MN)	78	27	11

*For year ending 31 August 1982. Data provided by CNET, Code N-2.

The obtained readability grade level corresponds to the grade level of reading ability required to understand the text. For example, a person reading at the 10th grade level should have full comprehension of a document written at the 10th grade readability level.

The readability analyses were obtained using the Computer Readability Editing System (CRES) described in TAEG Report 83 (Kincaid, Aagard, and O'Hara, 1980). TAEG has used the CRES for readability analysis of the Surface Warfare Officers School curriculum (Aagard, et al., 1981) and for essential reading material for enlisted personnel (Hamel, et al., 1982). As in these studies, samples of text were keyed into the computer (or read in if available in machine-readable form), and the readability grade levels were automatically obtained. The CRES also flags words not in a core vocabulary representing words a Navy trainee should know. These flagged words can be useful in identifying technical words (see appendix B) for glossaries for training students entering the particular "A" school.

SECTION III

RESULTS

Table 2 summarizes the average readability grade levels, setback rates, and attrition rates for the courses analyzed in this study. The data are presented in descending order of their mean readability grade level. The Electronics Technician curriculum was found to have the most difficult readability grade level, 12.6, which is first-year college level. The second most difficult course, Advanced First Term Avionics, was found to have a mean readability grade level of 11.9. Both are electronics courses. The least difficult course, Machinery Repairman, was found to have a readability grade level of 8.1. Although mean readability grade level is an important overall measure, the upper range of readability grade levels should be stressed when considering the trainee's ability to comprehend material. For instance, one very difficult publication in a school's curriculum might be very troublesome even for those whose reading ability matches the mean readability grade level of the course material.

Measures of academic difficulty shown in table 2 include percentages of academic setback and academic attrition. It is interesting to note that the course with the highest RGL, Electronics Technician, also had the highest percentage of setbacks and the third highest percentage of academic attrition of the 11 courses included in this study. Correlations were computed to assess the strength of the relationship between RGL and measures of academic difficulty. The correlation between mean readability grade level and percentage of setbacks was $r = .49$. This is considered a moderately high correlation although statistically not significant.[8] The correlation between readability grade level and percentage of academic attrition was found to be $r = .09$. This low correlation indicates little relationship between the two variables.

Table 3 shows recent data (FY 82) for the reading ability of Navy recruits. All recruits were tested using level D of the Gates-MacGinitie Reading Test (MacGinitie, 1978). Thirty-two percent of recruits were shown to have college level reading (above a grade level of 12.0). Recruits with this reading proficiency should not experience difficulty with the reading materials encountered in any of the schools surveyed in this study. Forty-eight percent of recruits were shown to have reading abilities between the 8th and 12th grade levels. The reading ability of this group would permit them to comprehend only part of the reading materials surveyed in this study. Twenty percent of recruits showed reading abilities at or below the eighth grade level. These recruits would have difficulty in comprehending text in any of the schools surveyed.

[8]Probability of obtaining a correlation of .49 (n=11) by chance is 19 percent. Conventionally, a probability of 5 percent is considered statistically significant.

TABLE 2. MEAN READABILITY GRADE LEVELS (RGL), SETBACK RATES, AND ACADEMIC ATTRITION PERCENTAGES FOR SELECTED SCHOOLS

Course Title	Mean RGL	RGL Range	Setback %*	Attrition %*
Electronics Technician (ET)	12.6	11.9-13.0	88	25
Advanced First Term Avionics (AFTA)	11.9	11.7-12.0	39	4
Mineman (MN)	11.3	9.1-14.4	27	11
Avionics (AV)	11.0	10.8-11.3	16	11
Air Traffic Controller (AC)	10.9	6.6-15.9	33	38
Aviation Antisubmarine Warfare Operator (AW)	10.6	9.4-12.1	37	10
Aviation Electronics Mate (AE)	10.3	6.4-12.4	34	7
Aerographer's Mate (AG)	10.0	6.7-11.8	35	16
Data Systems Technician (DS)	10.0	9.2-10.8	18	8
Strategic Weapons Systems Electronics (SWSE)	9.9	9.2-10.3	57	32
Machinery Repairman (MR)	8.1	7.1- 9.3	25	11
Overall Mean	10.3			

*For year ending 31 August 1982. Data provided by CNET, Code N-2.

TABLE 3. READING ABILITY* OF NAVAL RECRUITS (FY 82)

Grade Level Range	Number	Percentage
Above 12.0	25,536	32.3
10.1-12.0	22,986	29.1
8.1-10.0	14,707	18.6
6.1-8.0	12,896	16.5
4.1-6.0	2,539	3.2
Below 4.0	390	.5
Median = 10.9	79,054	
Mean = 9.8		

*Reading scores were obtained from the CMI Recruit Population Analysis Report produced by the Management Information and Instructional Systems Activity (MIISA).

SECTION IV

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The overall mean readability grade level of the school curricula sampled was 10.6. Comparing this to FY 82 figures on the average reading ability level of Navy recruits ($\bar{X}$ = 9.8, median = 10.9, see table 3) there would appear to be a match between readability grade level and reading grade level for courses sampled. However, difficulty range of the materials sampled varied widely within courses. Certain curriculum materials had readability grade levels considerably higher than the reading ability of the intended users.

The fact that mean readability grade level of the 11 sampled courses correlated positively with setback rates indicates that readability may be contributing to the setback problem. This appears to be particularly true of those schools which embody high technology (e.g., Electronics Technician "A" School and Advanced First Term Avionics School).

An examination of the curriculum materials used in the highly technical schools revealed the frequent use of many difficult technical words, required by the subject matter. The CRES analysis which calculates readablity grade level also flags uncommon words. Many of these uncommon words are technical words (e.g., gyrocompass) which have no substitute. Therefore, a supplemental list must be constructed for use with specialized materials. Appendix B presents an example of such a list for the Strategic Weapons Systems Electronics "A" School. A list like this is a tool for producing glossaries and vocabulary exercises for Navy technical school students needing reading instruction specific to the course. The production of such materials is likely to be an important part of carrying out the requirements contained in OPNAVINST 1510.11.

It should be noted that readability is just one measure of the comprehensibility of textual material. Other factors of comprehensibility such as content, vocabulary, sentence structure, and format are not addressed by readability formulas. Nevertheless, a very high RGL, such as 16 or above, is indicative of a problem, and thus signifies a need for simplifying the material. The CRES is one aid for improving not just readability but comprehensibility (e.g., vocabulary, sentence construction, test item format).

RECOMMENDATIONS

1. In accordance with OPNAVINST 1510.11 which gives CNET the responsibility to set readability and/or comprehensibility standards, the following are recommended:

- set readability grade level standards to match the mean reading ability of the intended reader when curriculum material is being written or revised
- use Gates-MacGinitie reading test results as one measure to derive target readability grade level requirements for particular schools
- use the CRES or the manual method prescribed by DOD specification MIL-M-38784A, Amendment 6, to assess readability grade level of curriculum material
- use the CRES to improve the comprehensibility of Navy curriculum material.

2. Develop glossaries, wherever appropriate, particularly for highly technical curriculum materials. Although most Navy schools now have glossaries, increased emphasis should be placed on their development and use. The CRES is a good tool for developing glossaries and should be used where available for this purpose.

3. Select additional courses for readability analysis based on the strategy for prioritization described in this study. Analyze the curricula of these courses as resources permit. In accordance with this recommendation, the CNET should task an appropriate organization for a programmatic effort. It is anticipated that several man-years would be required for analysis of remaining "A" schools.

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MacGinitie, W. H. Gates-MacGinitie Reading Tests. Boston: Houghton-Mifflin, 1978.

APPENDIX A

READABILITY GRADE LEVEL OF SAMPLED MATERIALS

The following are readability grade levels for each document analyzed for the school cited in section II of this report.

AIR TRAFFIC CONTROLLERS "A" SCHOOL

Title	Number	RGL
Charts and Publications	Information Sheet 9.9.1I CNTT-M1515	15.9
USAF/USN NOTAMS	Information Sheet 9.4.1I	14.2
Time and Basic Navigation	Information Sheet 9.5.1I CNTT-M1483	6.6
Search & Rescue	Information Sheet 9.6.1I CNTT-M1485	9.9
Air Traffic Control Procedures	Information Sheet OPNAV 3710.7 Excerpts	12.1
Airport Facilities and Lighti	Information Sheet 9.12.1I	11.0
ASR Approaches - Part I	CNTT-M1139	13.1
ASR Approaches - Part II	CNTT-1135	8.9
ATC Radar - Part I (ASR)	CNTT-M1071	11.0
Basic Radar Theory	CNTT-G87	8.5
Aviation Weather	CNTT-M1110	10.1
NavAids	CNTT-1338	11.1
Base Operations Laboratory	---------	9.3
Terminal Facility Equipment	CNTT-M1516	10.1
Control Tower Operator	CNTT-M1239	11.7
Overall		10.9

AVIATION ELECTRONICS MATE "A" SCHOOL

Title	Number	RGL
Positive and Negative Numbers	CNATT-M25	8.1
Fractions (Basic Math)	CNATT-P-4968	6.4
Powers of Ten	CNTT-M707	11.0
Magnetism	CNATT-M544	10.3
Magnetic Theory	CNATT-M154	11.2
Aircraft Wiring Practices and Basic Electrical Troubleshooting	CNTT-M1012	9.6
Basic Electronic Circuits	CNTT-M971	10.5
Aviation Electrician's Mate	NAVEDTRA 10348-D	12.2
Overall		10.3

ADVANCED FIRST TERM AVIONICS COURSE (AFTA) SCHOOL

Title	Number	RGL
Trainee Workbook, Phase IV, Unit 1	CNTT-M491	11.8
Trainee Workbook, Phase III, Unit 2	CNTT-M488	11.7
Trainee Workbook, Phase III, Unit 1	CNTT-M542	11.5
Trainee Workbook, Unit 2	CNTT-M1463	12.0
Overall		11.9

AEROGRAPHER'S MATE "A" SCHOOL

Title	Number	RGL
Decoding & Plotting of the International Analysis Code	CNTT-L186	8.1
Decoding Radio Messages and Plotting Radiological Fallout Diagrams	3ABR25130-2-PT-305J	7.2
The APT Predict Message and Tracking Board	3ABR25130-2-PT-407A	6.7

AEROGRAPHER'S MATE "A" SCHOOL (continued)

Title	Number	RGL
Skew T, Log P Diagram	3ABR25130-2-PT-408A	5.8
Pilot Reports (PiRep Code)	3ABR25130-SG-112	8.7
Cloud Forms	3ABR25130-WB-104B	8.2
Types of Observations	3ABR25130-WB-110	8.0
Oceanic Circulation	CNATT-L129	9.4
Sound Ray Theory	CNATT-L131	8.7
Basic Principles of Sea and Swell	CNTT-L149	8.7
Meteorological Satellite Terms and Equipment	3ABR25130-2-PT-303A	8.4
Properties of Sea Water	3ABR25130-2-PT-401	10.9
Aerographer's Mate 3 & 2	NAVEDTRA 10363-E	9.6
Weather for Aircrews	AFM 51-12	11.4
Federal Meteorological Handbook	FMH-1B	11.8
Surface Synoptic Codes	FMH-2	8.2
Overall		10.0

AVIONICS (AQ,AT,AX) "A" SCHOOL

Title	Number	RGL
Introduction to AM Communications Unit 1, Module 1, Volume III	CNTT-M1311	11.3
Introduction to AM Communications Unit 1, Module 1, Volume II	CNTT-M1314	10.8
Overall		11.0

AVIATION ANTISUBMARINE WARFARE OPERATOR "A" SCHOOL

Title	Number	RGL
AW(A1) Prerequisite Mathematics	CNTT-M1178	9.4
Students' Guide, Vol. 1, Phases I & II	CNTT-M1184	12.1
Overall		10.6

DATA SYSTEMS TECHNICIAN "A" SCHOOL

Title	Number	RGL
Trainee's Guide for the COMTRAN TEN	----------	10.2
Learner's Guide, Vol. I	PX-10773-1	9.7
Learner's Guide, Vol. II	PX-10773-2	10.8
Trainee's Guide, Phase A-1	----------	9.2
Overall		10.0

ELECTRONICS TECHNICIAN "A" SCHOOL

Title	Number	RGL
Telecommunication Systems	ET/A-18691	13.1
Radar (AN/SPS-10)	ET/A-18093	11.9
Advanced Electronics and Circuit Analysis	ET/A-18465	13.0
Overall		12.6

MINEMAN "A" SCHOOL

Title	Number	RGL
Student Guide, Unit 2	----------	10.6
Student Guide, Unit 3	----------	9.4
Student Guide, Unit 6	----------	11.2

MINEMAN "A" SCHOOL (continued)

Title	Number	RGL
Student Guide, Unit 7	----------	9.1
Student Guide, Unit 8	----------	9.7
Technical Manual	NAVSEA OP 3504, Vol. 1	13.4
Technical Manual	NAVSEA OP 4410, Vol. 5	10.7
Technical Manual	NAVSEA OP 4410, Vol. 1	14.4
Technical Manual	NAVSEA OP 2572	13.4
Technical Manual	NAVSEA OP 3529	11.5
Overall		11.3

MACHINERY REPAIRMAN "A" SCHOOL

Title	Number	RGL
Student's Guide Volume 1, Phase 1	----------	8.3
Student's Guide Volume 1, Phase 2	----------	8.2
Student's Guide Volume 1, Phase 3	----------	7.9
Student's Guide Volume 1, Phase 4	----------	8.5
Student's Guide Volume 1, Phase 5	----------	7.4
Student's Guide Volume 1, Phase 6	----------	7.1
Machinery Repairman 3 & 2	NAVEDTRA 10530-D	9.3
Overall		8.1

STRATEGIC WEAPONS SYSTEMS ELECTRONICS "A" SCHOOL

Title	Number	RGL
Basic Digital Computer Fundamentals	NAVTECHTRA 121-0142 Rev. A, SSWB-BDC1, Vol. 2	9.8
Inductance	002/2-3-4	9.2
Trainee Guide	NAVTECHTRA 121-0142 Rev. A, Vol. 1	10.3
Overall		9.9

APPENDIX B

TECHNICAL WORDS IDENTIFIED BY CRES ANALYSIS

STRATEGIC WEAPONS SYSTEMS ELECTRONIC "A" SCHOOL

bit-by-bit
CEMF
coefficient
counterelectromotive
capacitive
cathode-ray
CCW
CREO
CW
component
crystal-controlled
comparator
converter
digital
DMM
DSflux
five-bit
flip-flop
four-bit
free-running
fractional
half-cycle
HZ
inductive
inductor
inductosyn
inertia
KHZ
Kirchhoff
K-F/F
lenz
LSD
microheneries
microsecond
misaligned
multivibrator
mylar
NMSD
ODS
OPS
oscilloscope
over-range
permeability
pin-jacks
potentiometer
probe
repulsion
resolver
representation
repunched
S1-S
S2-S
self-inductance
self-synchronous
synchros
sine-wave
sign-number
SSWB
tp"A"

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